

UNUSUAL PARTIAL SECOND BROODS OF LEPIDOPTERA IN NORTH-EAST SCOTLAND DURING 2003

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Abstract

Many moths that are normally univoltine in north-east Scotland produced partial second generations during the hot summer and autumn of 2003. Details are provided for 34 species. For some of these, records of second brood individuals in the region are unprecedented; in several cases they would be unusual even in the south of England. The possible influence of global warming is discussed. The data also provides evidence that the normally univoltine Scottish *Diarsia* species is *D. rubi* and not *D. florida*.

Introduction

There is increasing evidence that global warming (however caused) is already having demonstrable effects on Britain's Lepidoptera. These effects fall into three categories. First, species that are on the wing in spring and early summer are emerging earlier, at least when judged on the date of the first sighting (Alston, 2001). Secondly, the range of many species is gradually extending northwards. This has been particularly well-studied in butterflies (Parmesan *et al*, 1999) but it also applies to moths (Parsons, 2003). North-east Scotland itself is regularly gaining new species from the south (Palmer *et al*, 2002). A third effect has so far received less attention. It involves the production of partial second broods by species which are normally univoltine in a particular region.

In summer 2003, the latter phenomenon was particularly noticeable in North-east Scotland (here defined as Watsonian Vice-Counties 91-94: respectively Kincardineshire, South Aberdeenshire, North Aberdeenshire and Banffshire). Very few moths are regularly bivoltine here. Detailed records have been kept since 1990 at my home site at Ordiquhill in Banffshire, with particular interest in flight periods. They show that, of the resident macros, only Garden Carpet *Xanthorhoe fluctuata* and Grey Pine Carpet *Thera obeliscata* normally produce a second brood equally as numerous as the first. A few other species that are regularly bivoltine in southern Britain occasionally produce second brood individuals here in particularly good summers.

Because partial second broods are so rare in North-east Scotland, the events of summer 2003 aroused much interest, causing detailed records to be kept. For the purposes of this paper, all observers known to operate in the region were contacted and asked for data. In total, unusual or unprecedented second brood individuals were recorded from 34 moth species. Only four of these were micros, perhaps because their habits are less well-known. Also, most records were from light traps.

Flight periods in North-east Scotland often differ from those in southern Britain. This caused occasional problems in deciding whether a moth was genuinely from a second brood, not just a very late individual from a prolonged single brood. In the following list, I have gone by the balance of probabilities but erred on the side of

caution. One criterion used was a sizeable gap (often a month or more) with no sightings before fresh individuals of the presumed second generation appeared. A further strong indication came from the size of the moths. In many species, the presumed second brood individuals were far smaller than average, some being described as tiny. Even so, a few of the records that follow might conceivably represent delayed development or emergence in an unusually hot and dry year, though the observers considered this unlikely. Finally, there is the question of whether the second brood individuals were produced locally, or whether they could have been migrants from further south. During the main period in question, late August to early October, surprisingly little immigration was noted in North-east Scotland. Even expected migrants like *Nomophila noctuella* and Dark Sword-grass *Agrotis ipsilon* were scarce or absent. Furthermore, most of the species that produced second broods have no reputation as migrants or strays.

List of species involved

Tineidae

Monopsis laevigella (Denis & Schiffermüller.)

Ordiqhill: several from 3.ix.2003, after gap since late July. No previous Gen.II records.

Oldmeldrum: several in September 2003 (MRY).

Heath & Emmet (1985) state "perhaps bivoltine in the south".

M. weaverella (Scott)

Ordiqhill: several from 3.ix.2003, after long gap. No previous Gen.II records.

Oldmeldrum: seen in September 2003 (MRY).

Emmet in Emmet & Heath (1992) charts life history as incompletely known, but univoltine.

Tortricidae

Celypha lacumana (Denis & Schiffermüller)

Ordiqhill: singles (very small) on 5.ix and 16.ix.03 after long gap. No previous Gen.II records.

Cluny: one on 7.ix and four on 14.ix.03 (HG).

Oldmeldrum: many more small specimens than usual in September 2003 (MRY).

Apotomis semifasciana (Haworth)

Ordiqhill: singles on 12.ix and 18.ix.03 after gap since July. Previous latest was on 7.viii.98.

Bradley, Tremewan & Smith (1979) give as univoltine, in July.

Geometridae

Small Dusty Wave *Idaea seriata* (Schrank)

Oldmeldrum: several in late September 2003 – unprecedented: normally July/early August (MRY).

Single-brooded in northern Britain (Skinner, 1998).

Flame Carpet *Xanthorhoe designata* (Hufnagel)

Ordiqhill: 20.v – 22.vii, then 6.viii – 3.ix.2003, equally numerous but smaller specimens.

1990 – 2002: Gen.II examples in 5 out of 13 years, most being three in 2002.

Alford: one on 22.viii.03; Cluny: one on 21.viii.03 (HG).

Monymusk: 21.v – 16.vii (total = 16), then 27.vii – 9.ix.2003 (total = 97) (RMP).

Oldmeldrum: one on 2.ix.2003 (MRY).

In Scotland, second brood only occurs in favourable years (Skinner, 1998)

Purple Bar *Cosmorhoe ocellatus* (Linnaeus)

Oldmeldrum: one on 3.ix.2003 (MRY). Normally one brood here, late June to mid August.
 Partial second generation in the south, one generation in the north (Waring & Townsend, 2003).

Small Phoenix *Ecliptopera silaceata* (Denis & Schiffermüller)

Ordiquhill: 20.v – 27.vi (up to 8 per night), then 11.viii – 14.ix.2003 (total = 9), smaller moths.
 1990 – 2002: only one Gen.II example, on 2.ix.1999.

Auchnagatt: 28.v – 20.vi, then 6.viii – 2.ix.2003 (total = 8) (CJH).

Cluny: one on 7.ix.2003 (HG).

Inchmarlo: one on 20.viii.03 (CWNH).

Monymusk: six between 15.viii – 20.ix.2003 (RMP).

Oldmeldrum: one on 2.ix.03 (MRY).

A second generation occurs in southern England, late July and August (Skinner, 1998).

Common Marbled Carpet *Chloroclysta truncata* (Hufnagel)

Ordiquhill: 16.vi – 31.vii.2003; then singles on 15.ix and 17.ix.2003, both small specimens.

1990 – 2002: one brood, mid June to early August; no suspected Gen.II examples seen.

Both univoltine and bivoltine races occur in Scotland (Skinner, 1998, Waring & Townsend, 2003).

Green Carpet *Colostygia pectinataria* (Knoch)

Auchnagatt: last of main brood on 21.vii.2003, then two small individuals on 9.x.2003 (CJH).

Inchmarlo: fresh specimen on 14.x.2003 (CWNH).

Unprecedented: normally one extended brood here, end of June until late August. Skinner (1998) notes an occasional and partial second generation in southern England.

Golden-rod Pug *Eupithecia virgaureata* Doubleday

Ordiquhill: 20.v – 24.vi, then small individual on 6.viii.2003 - unprecedented.

1990 – 2002: strictly one brood, mid May to late June.

Cluny: one on 4.viii.2003 (HG).

Oldmeldrum: singles on 10.viii and 17.viii.2003 (MRY).

Double-striped Pug *Gymnoscelis rufifasciata* (Haworth)

Ordiquhill: small individuals on 1.ix. and 6.ix.2003 – unprecedented at this site.

1990 – 2002: strictly one brood, late May through June.

Waring & Townsend (2003): one generation in parts of northern Britain.

Tawny-barred Angle *Macaria liturata* (Clerck)

Inchmarlo: one on 23.viii.2003 (CWNH).

Skinner (1998): single-brooded except in southern England.

Barred Umber *Plagodis pulveraria* (Linnaeus)

Monymusk: a small male on 9.ix.2003; genitalia checked to confirm species (RMP).

South (1907-09) is the only British author to describe this species as anything other than univoltine.

Brimstone Moth *Opisthocraptis luteolata* (Linnaeus)

Ordiquhill: 18.v – 30.vi, then 23.viii – 20.ix.2003, with two in August and 12 sightings in September.

1990-2002: no September records: total of 8 individuals in August over seven different years.

Alford: one on 22.viii.2003. Cluny: singles on 7.ix and 14.ix.2003 (HG).

Auchnagatt: 2.ix – 25.ix.2003 (total = 14) (CJH).

Inchmarlo: 13.ix – 23.ix.2003 (CWNH).

Monymusk: 19.viii – 26.ix (total = 80+) then singles on 13.x and 14.x.2003 (RMP).

Oldmeldrum: late September 2003 (MRY).

Normally univoltine in northern Britain, overwintering as a pupa (Porter, 1997).

Common White Wave *Cabera pusaria* (Linnaeus)

Monymusk: one small example. 1.ix.2003 (RMP).

Bivoltine in southern Britain (Skinner, 1998), but no previous Gen.II records known from our area.

Light Emerald *Campaea margaritata* (Linnaeus)

Inchmarlo: one on 19.ix.2003 (CWNH).

Monymusk: singles on 9.x and 11.x.2003 (RMP).

Partial second generation in southern England (Skinner, 1998), but no previous autumn records here.

Barred Red *Hylaea fasciaria* (Linnaeus)

Inchmarlo: one on 1.x.2003 (CWNH).

Normally late June to mid August here. Only South (1907-09) suggests a partial second brood.

SphingidaePoplar Hawk *Laotioe populi* (Linnaeus)

Ordiquhill: 22.v – 12.vii, then singles on 24.viii and 2.ix.2003.

1990 – 2002: latest-ever was 22.vii.1998, with no suspicions of a second brood.

Aberchirder: one on 24.viii.2003 (RS).

Sometimes a partial second generation in the south (Waring & Townsend, 2003).

NotodontidaeIron Prominent *Notodonta dromedarius* (Linnaeus)

Ordiquhill: 14.vi – 4.viii, then singles on 18.viii, 21.viii, 3.ix and 15.ix.2003.

1990 – 2002: long flight periods, but only one convincing Gen.II example, on 1.ix.1999.

Alford: one on 22.viii.2003 (HG).

Oldmeldrum: one on 27.viii.2003 (MRY).

Usually single-brooded in the north (Skinner, 1998).

Pebble Prominent *N. ziczac* (Linnaeus)

Ordiquhill: 18.v – 29.vii, then small specimen on 16.viii.2003.

1990 – 2002: long first broods; the only probable Gen.II examples on 11.viii and 16.viii.1998.

Oldmeldrum: one on 17.viii.2003 (MRY).

Single-brooded in the north (Skinner, 1998).

Lesser Swallow Prominent *Pheosia gnoma* (Fabricius)

Ordiquhill: 30.v – 16.vii, then one on 24.viii.2003.

1990 – 2002: long broods, sometimes into August, but no convincing Gen.II examples.

Alford: one on 22.viii.2003. Cluny: one on 21.viii.2003 (HG).

Oldmeldrum: one on 27.viii.2003 (MRY).

One generation in northern Scotland (Waring & Townsend, 2003).

Swallow Prominent *P. tremula* (Clerck)

Ordiquhill: one on 24.viii.2003.

1990 – 2002: single brood, late June to early August, with no convincing Gen.II examples.

Oldmeldrum: one on 23.viii.2003 (MRY)

Single-brooded in the north (Skinner, 1998).

Coxcomb Prominent *Ptilodon capucina* (Linnaeus)

Ordiquhill: 5.vi – 19.vii, then singles on 23.viii and 5.ix.2003.

1990 – 2002: from late May into early August, but only one Gen.II example, on 13.ix.1999.

Aberchirder: one on 24.viii.2003 (RS).

Auchnagatt: singles on 24.viii, 30.viii & 4.ix.2003 (CJH).

Generally considered bivoltine, but not so in this region

.Buff-tip *Phalera bucephala* (Linnaeus)

Inchmarlo: at least one from 26.viii to 4.ix.2003, perhaps same moth retrapped (CWNH).
Given as univoltine by all British authors.

NoctuidaeFlame Shoulder *Ochropleura plecta* (Linnaeus)

Ordiquhill: 20.v – 17.vii, then 6.viii – 16.ix.2003 (Gen.II total = 15).
1990 – 2002: late May sometimes into August, but Gen.II examples in four years only (total = 5).
Alford: one on 22.viii.2003; Cluny: two on 21.viii.2003 (HG).
Auchnagatt: 7.vi – 23.vii, then singles on 24.viii, 2.ix & 4.ix.2003 (CJH).
Oldmeldrum: late September 2003 (MRY).
Generally considered bivoltine, but not so in this region.

Small Square-spot *Diarsia rubi* (Linnaeus)

Ordiquhill: 11.vi – 6.viii, then 31.viii – 18.x.2003 (Gen.II total = 78).
1990 – 2002: Gen.II individuals in 8 years only (total = 11), some possibly migrants.
Auchnagatt: Gen.II 4.ix – 14.x.2003 (total = 19) (CJH).
Cluny: two on 7.ix and one on 1.x.2003 (HG).
Inchmarlo: 14.ix – 21.ix.2003 (CWNH).
Monymusk: 4.ix – 2.x.2003 (total = 13) (RMP).
Oldmeldrum: late September 2003 (MRY).
Univoltine in Scotland (Heath & Emmet, 1979).

Bright-line Brown-eye *Lacanobia oleracea* (Linnaeus)

Ordiquhill: 10.vi – 22.vii, then small specimen on 1.ix.2003.
1990 – 2002: from June well into August in late years, but never any suspicion of Gen.II.
Cluny: one on 1.x.2003 (HG).
With a small second brood in southern England (Heath & Emmet, 1979).

Smoky Wainscot *Mythimna inopura* (Hübner)

Cluny: one on 1.x.2003 (HG). Unprecedented here, though lingers into September in cool summers.
With occasional and partial second brood in southern England (Skinner, 1998).

Small Angle Shades *Euplexia lucipara* (Linnaeus)

Auchnagatt: one on 24.ix.2003 (CJH). Unprecedented in NE Scotland.
With very occasional and partial second generation (Skinner, 1998).

Burnished Brass *Diachrysia chrysitis* (Linnaeus)

Ordiquhill: 24.vi – 9.viii, then small specimens on 14.ix & 18.ix.2003.
1990 – 2002: from late June or July into late August in poor summers, but no Gen.II suspected.
Auchnagatt: 28.vi – 6.viii, then singles on 14.ix, 16.ix, 17.ix & 24.ix.2003 (CJH).
Cluny: one on 14.ix.2003 (HG).
Univoltine from the Midlands northwards (Heath & Emmet, 1983).

Gold Spot *Plusia festucae* (Linnaeus)

Auchnagatt: 24.vi – 25.vii, then one on 14.ix.2003 (CJH).
Oldmeldrum: one on 6.ix.2003 (MRY).
In much of Scotland always single-brooded (Skinner, 1998).

The Spectacle *Abrostola tripartita* (Hufnagel)

Ordiquhill: 21.v – 20.vii, then very fresh specimen on 8.viii.2003.
1990 – 2002: prolonged single emergence, but only one Gen.II record, on 17.viii.1995.
Occasional and usually partial second generation in southern Britain (Skinner, 1998).

The Snout *Hypena proboscidalis* (Linnaeus)

Cluny: small specimen on 1.x.2003 (HG).

Inchmarlo: one on 18.ix.2003 (CHo).

Monymusk: two tiny specimens on 25.ix.2003 (RMP).

Bivoltine in southern England (Heath & Emmet, 1983) but no previous Gen.II records here.

Discussion

The weather in 2003 was unusually dry and sunny throughout Britain, continuing the recent trend towards warmer summers. The most noteworthy feature, however, was an exceptionally hot spell in the first ten days of August when a new UK temperature record of 38.1°C was set at Gravesend. Even my garden thermometer registered over 32°C on 9 August.

Arguably it was this hot spell that triggered the unprecedented partial second broods of so many moths that hitherto have been strictly univoltine in North-east Scotland. For most species, the timing seems to fit: second brood individuals appeared roughly a month to six weeks after the early August hot spell. This would provide the time-scale needed for caterpillars to feed up and pupate instead of overwintering, or for pupae to form up instead of diapausing until spring. Ironically, when the second broods did emerge, the weather was no longer exceptional.

A relatively early spring was no doubt part of the equation. Springs tend to be particularly cold and late in North-east Scotland, but by the end of May 2003 I had already recorded adults of 61 species of macro-moth at Ordiquhill. This compares with an average of 46 species by that date (range 21 – 60) in the 12 previous years. Thus many of the potentially double-brooded species had got off to a good start.

Time alone will tell if the events of 2003 part of a definite trend, or this was simply a year when the life cycles of some moths were confounded by unusual weather. Certainly it is doubtful whether most of the species concerned actually benefited by producing partial second broods. At their low density, some of the individuals concerned may not have been able to find mates. Even if fertile eggs were laid, autumn comes quickly up here. It seems unlikely that caterpillars hatching in September or later would have time to reach the appropriate overwintering stage. For example, willow-herb *Epilobium* was already in a sorry state when the second brood of Small Phoenix appeared. Far from promoting the ability to produce a second brood, 2003 might have ensured that the genes concerned were removed from the population.

Fewer than 1% of the macro-moths in North-east Scotland are fully bivoltine in an average year. Instead, a common strategy seems to be the extended single brood, often lasting 10 weeks or more. For example, many of the prominents (Notodontidae) have a protracted single flight from late May to early August in some years. Other species show a similar pattern. Especially in a cool summer, our single brood can almost span the period occupied by two more discrete generations in the south. Its timing is variable, depending on the weather, being a month or more later in cool summers than in good ones. In the uncertain Scottish climate, presumably this flexibility is valuable.

Factors other than temperature may also favour a single brood. Even if the climate of Scotland warms in the future, day length will stay the same. Many caterpillars feed nocturnally, presumably to avoid predation, yet summer nights here are considerably shorter than those in southern England, especially for a month either side of the midsummer solstice. Thus reduced nocturnal feeding time could work against bivoltinism in northern Britain, irrespective of temperature.

It is also interesting to consider the species that (as far as we know) failed to produce a partial second generation in North-east Scotland 2003, even though they are bivoltine further south. They included Early Thorn *Selenia deutaria*, Sallow Kitten *Furcula furcula*, Ruby Tiger *Phragmatobia fuliginosa* and Nut-tree Tussock *Colocasia coryli*. All were out by May in 2003, but no second brood resulted. This strongly suggests their univoltinism here is genetically controlled rather than determined by temperature.

Finally, the strong partial second brood of Small Square-spot was convincing evidence that the normally univoltine Scottish moths are *Diarsia rubi* and not *D. florida* (whatever the true status of that taxon), answering the query of Palmer & Gould (2003).

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The Straw Dot moth *Rivula sericealis* (Scop.) (Lep.: Noctuidae): how many broods?

The observation by Brian West (*Ent. Rec.* **115**: 286-287) that the Straw Dot *Rivula sericealis* is regularly double-brooded, and occasionally triple-brooded, in his garden on the outskirts of south-east London, prompted me to look more closely at my own data on this species. Though there were similarities between our two gardens, there were also differences. The opportunity was taken, therefore, to examine the situation in closer detail.

A preliminary examination of the literature suggests that existing data on voltinism in this species is sparse and inconclusive and does not allow any real decision to be made concerning whether there are two broods of adults or one protracted brood. For Britain, Barrett (1900. *The Lepidoptera of the British Islands*) states simply that the moth is on the wing from the end of June to the end of August. More recently, Bretherton, Goater & Lorimer, writing in volume 10 of *Moths and Butterflies of Great Britain and Ireland* (Harley Books, 1983) observed that “It is not possible to state the number of generations with any certainty, as the moth may be seen in any month from late May to early October; much probably depends on the early summer rainfall and consequent succulence of the foodplant after midsummer; so that hibernated larvae complete their growth at varying speeds in different years. The resulting emergence is spread throughout June and July and there is at least one more complete generation, possibly even a partial third in southern England.” The possibility exists that both the phenology (the period when it is an adult) and the voltinism (number of generations per year) may be affected by latitude and so a quick examination of the European literature is also of interest and relevance.

For Northern Europe, Skou (1991. *Nordeus Ugler*) writes “In Denmark and southern Sweden from mid June to mid September, probably in two continuous generations. Further to the north only one generation from late June to mid August. I am most grateful to Peder Skou for e-mailing me a translation of his text for this species. It may be worth bearing in mind that in terms of latitude, Denmark and southern Sweden extend approximately from Newcastle-upon-Tyne to Orkney. For France, Culot (1915. *Noctuelles et Géométriques d'Europe*, volume 2) notes the adult from May to September, making no comment on voltinism; later French texts do not appear to give flight periods. For Central Europe, Nowacki (1998. *The Noctuids of Central Europe*) reports positively “May to September in two generations”. For the